An Introduction to IMP/IMS

In 2003 the US Government revised its acquisition policies with a procurement strategy focused on process improvement and acquisition reform implemented by performance-based management.

Glen B Alleman
Niwot, Colorado

Planning projects usually starts with tasks and milestones. The planner gathers this information from the participants – customers, engineers, subject matter experts. This information is usually arranged in the form of activities and milestones. PMBOK defines "project time management" in this manner. The activities are then sequenced according to the projects needs and mandatory dependencies.

The usual critical path methods are then used to determine the estimated completion date, risk areas of the project and other statistical planning data.

What's missing from the concept of this task-oriented schedule is the realization that the plan is not the same as "done." A description of "done" is usually not part of the plan in an explicit manner. Rather is usually found inside of a specification. It's there in implicit form – after all the tasks are complete.

In the US Department of Defense version of PMBOK Section 6 (Project Time Management) this task-oriented approach is replaced by IMP/IMS.

Why was this done? The DoD version as well as the US Air Force IMP/IMS guides don't explicitly state the reason for replacing the traditional planning approach with IMP/IMS.

Program Management is a Full Contact Sport

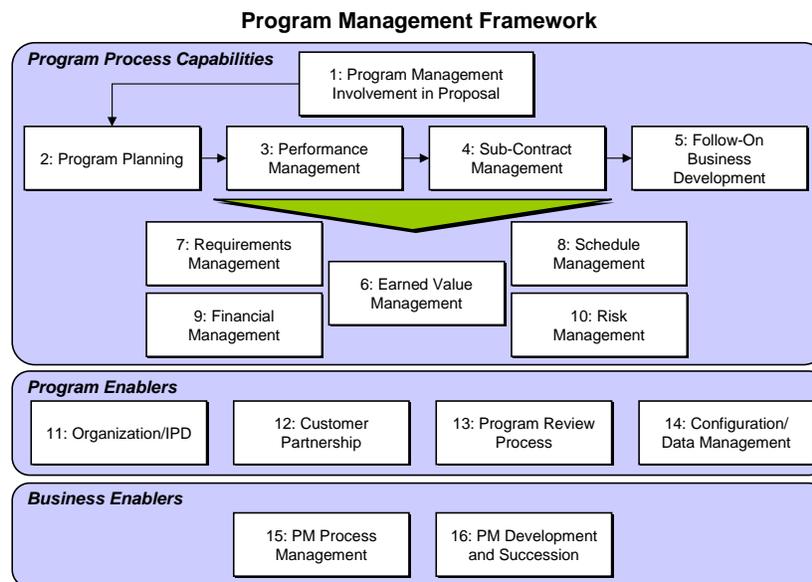"WOULD YOU PLEASE ELABORATE ON 'THEN SOMETHING BAD HAPPENED.'"
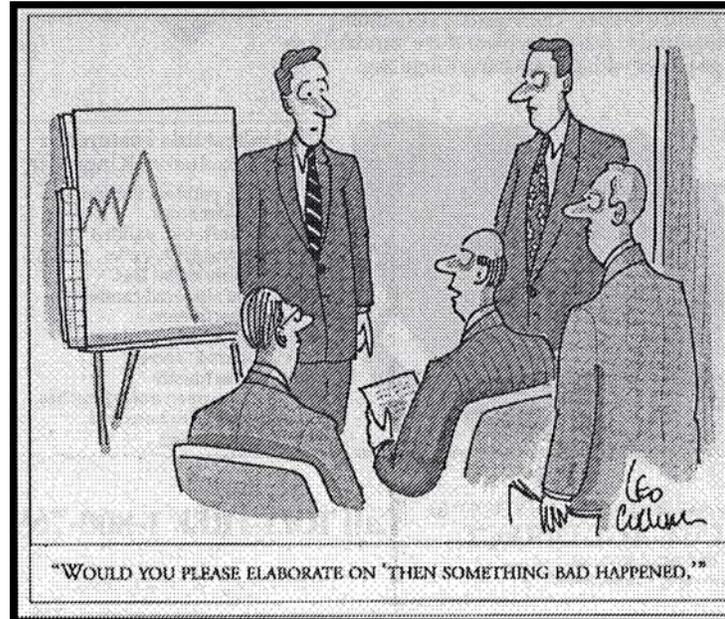
IMP/IMS 2$^{/54}$

2

We've all had experiences in much the same as the carton charters shown here. Things are going along well, even the numbers all look good. Then the "surprise" happens. Sometimes out of the blue, sometimes with a clear vision of the train wreck happening before our eyes.

Why does the happen? If there was a simple answer to this question all the efforts of program management, tools and processes would not be needed. The answer is we don't really know why projects fail in any detail that would allow us to avoid failure with certainty. There are many authors, professional organizations, and government agencies who profess to have a solution.

But in the end its simply not possible to state assuredly how to avoid failure.

Opportunities for improvement certainly exist. Obvious failure modes can be identified and avoided. Postmortems can easily identify the gaps that occurred with or without the knowledge of the project managers, customers, and engineers.

Booz Allen Hamilton's
16 Program Management Processes

Program Management Framework

Program Process Capabilities

1: Program Management Involvement in Proposal

2: Program Planning → 3: Performance Management → 4: Sub-Contract Management → 5: Follow-On Business Development

7: Requirements Management
8: Schedule Management
6: Earned Value Management
9: Financial Management
10: Risk Management

Program Enablers

11: Organization/IPD
12: Customer Partnership
13: Program Review Process
14: Configuration/ Data Management

Business Enablers

15: PM Process Management
16: PM Development and Succession

IMP/IMS 3/54

3

Booz Allen Hamilton defined 16 processes for program management. These all appear obvious on the surface as any good idea does.

The challenge is to put these practices into practice on real programs with real people and real customers.

The Program Process Capabilities (1 – 10) are the core of the IMP/IMS outcomes. Planning, performance management, subcontract relations, cost, and earned value are critical operational activities for the success of any program.

For these processes to be effective, there has to be a clearly defined statement of work, a cooperative customer, a skilled and qualified team, proper funding, and most importantly a feasible solution to the customer's needs.

But even with all these pre-conditions, projects get in trouble.

What's missing?

The IMP/IMS approach would say what's missing is a way to assess the incremental progress of the program in a way that can be measured in unambiguous terms. By defining "done" in terms of events, accomplishments, and criteria, progress of the program can be measured.

Why IMP/IMS?

- **Proposal Preparation**

    – Emphasize "real" integrated product development

    – Provide flexibility in performing detailed planning

- **Contract Award**

    – At post-award conference, provides a basis of mutual understanding

- **Program Execution**

    – Identify and assess program progress based on "done" rather then passage of time or effort expended

    – Assess program maturity through pre-defined accomplishments

IMP/IMS 4$^{/54}$

4

There are no simple answers for the question – why use IMP/IMS? As well there doesn't seem to be much in the way of documentation for the deployment of IMP/IMS.

The fact is though that the world is littered with failed projects. Even after decades of professional development, bodies of knowledge, endless seminars and training processes and even Presidential commissions.

There are an equal number of successful projects. The parameters of project success or project failure are elusive. But one thing is clear, without a concise definition of "done", no process will help.

What is the Integrated Master Plan?

- **The IMP is an *event based* plan, rather than a *task based* plan**
  - A hierarchy of program events defines the program flow
  - Each event is supported by specific accomplishments
  - Each accomplishment has specific criteria to be satisfied
- **The IMP tracks the step-by-step completion of the required accomplishments for each event**
- **The IMP demonstrates the satisfactory completion criteria for each accomplishment**

IMP/IMS 5/54

5

The Integrated Master Plan is a collection of milestones (IMP/IMS calls them events) that form the process architecture of the program. This means the sequence of events that will result in a deliverable product or service.

Delivering products or services is relatively straight forward in many cases. List the tasks to be done, arrange them in the proper sequence, execute this "plan."

Several problems appear immediately:

- The description of "done" is many times missing for the intermediate activities.
- As products or services are delivered the maturity of the program is as critical as quality, functionality, and other program attributes. This maturity is an insurance policy against problems encountered in the program.
- Program partners, integration activities, subcontractors all have unknown or possibly unknowable impacts on the program
- Exposing "done" to and from the IPTs builds a shared version of "done"

What is the Integrated Master Plan?

- **The IMP is *NOT* based on calendar dates, therefore it is not schedule oriented**
  - Each event is completed when its supporting accomplishments are completed
  - This completion is evidenced by the satisfaction of the criteria supporting each of the accomplishments
- **Many of the events in an IMP are fixed by customer milestones**
  - PDR, CDR, Production delivery
- **Intermediate events are defined by the supplier**
  - Integration and test, Software releases, TRR

IMP/IMS 6/54

6

The critical attribute of the IMP is its focus on events. This is in comparison to effort or task focused planning.

The event focus asks and answers the question "what does done look like?" Rather than what work has been done. Certainly work must be done to complete a task. But focusing on the work hides the more important metric of "are we meeting our commitments?"

Meeting commitments is critical but the criteria for judging if the commitments are being met comes first. This is where Significant Accomplishments and their Accomplishment Criteria become important. It is important to meet commitments, but recognizing when the commitment has been met is even more important.

What is the Integrated Master Schedule?

- **The IMS flows directly from the IMP, and is linked to:**

  - Work Breakdown Structure

  - Statement of Work

  - Earned Value Management System

- **The IMS is used to manage the day-to-day execution of the program**

  - Tracking program technical and schedule status

  - Managing and mitigating program risk

  - Incrementally assessing the maturity of the program

IMP/IMS 7/54

7

The term Integrated Master Schedule sounds obvious on the surface. A project schedule that is "integrated." But what does integrated really mean? Integrated at what level? Integrated with what components?

The IMS integrates the Events with Tasks. The work efforts that produce accomplishments, assess these accomplishments through criteria and complete the Events are the basis of the IMP/IMS

The Importance of the IMP/IMS

- **The IMP/IMS is the single most important document to a program's success**
    - It clearly demonstrates the providers understanding of the program requirements and the soundness of the approach a represented by the plan

- **The program uses the IMP/IMS to provide:**
    - Up Front Planning and commitment from all participants
    - A balanced design discipline with risk mitigation activities
    - Integrated requirements including production and support
    - Management with an incremental verification for informed program decisions

IMP/IMS 8/54

8

This may sound like hype, but without a clear and concise description of what is to be delivered, tied to the plan, with measurement criteria the program has no way of knowing how it is performing other than the passage of time

The emphasis on "maturity" is seen in product development programs. In "one off" programs there is no cyclic process on which to base maturity of the product.

But in these "one off" programs, progress of the program toward the goal can be seen a maturing.

Misconceptions of IMP/IMS

- **Too big and burdensome for our small dollar program**

- **We'll spend gobs of B&P money maintaining a thick document**

- **It's a management tool not a technical tool**

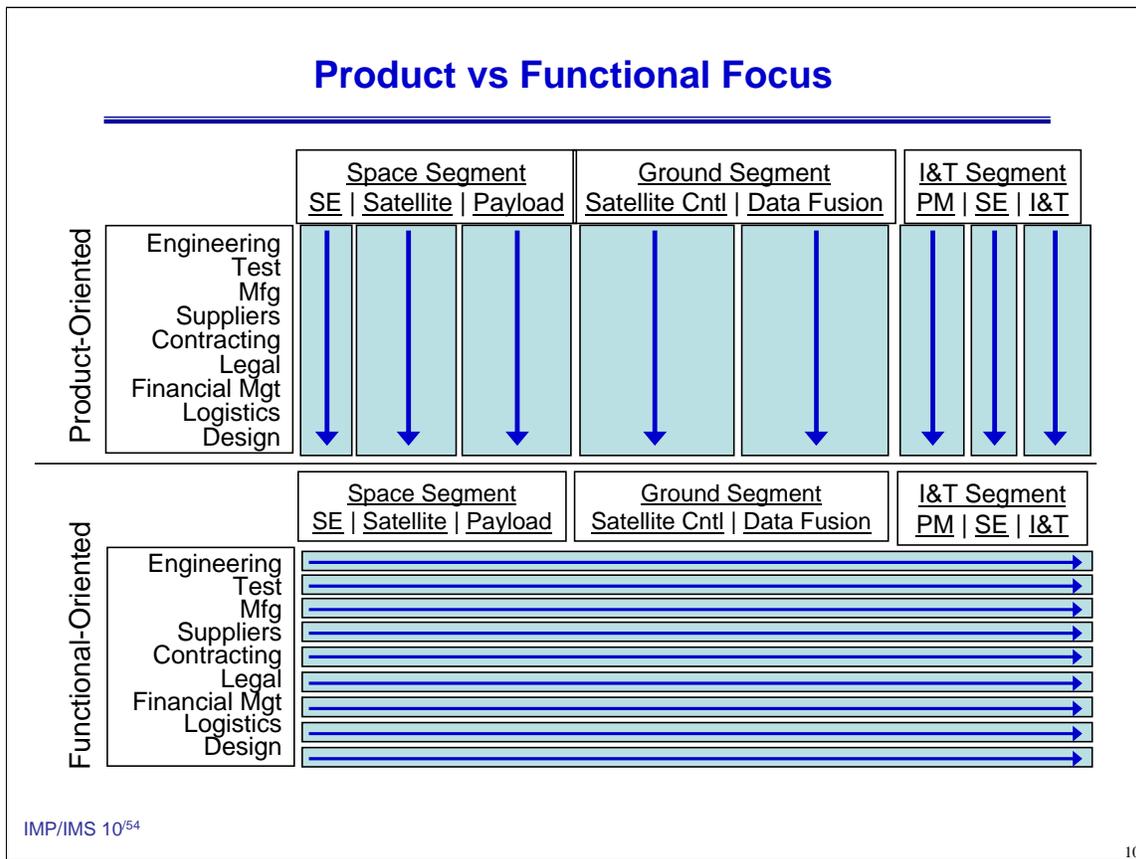- **I want IPTs without the burden of IPD or IMP/IMS**

IMP/IMS 9/54

9

The first impulse to IMP/IMS is "this is great on large weapons systems procurements." SBIRS for example. But for our small to moderate program it's a lot of work for not much benefit.

The second misconception is IMP/IMS is part of the proposal and procurement process, used to assess contractors on their ability to manage the program. This is true. BUT if this assessment shows competence in the proposal phase, why not continue the processes during the execution phase.

"Test as you Fly," should be augmented with "Execute as you Propose."

Product vs Functional Focus

	Space Segment SE | Satellite | Payload	Ground Segment Satellite Cntl | Data Fusion	I&T Segment PM | SE | I&T

Product-Oriented

Engineering
Test
Mfg
Suppliers
Contracting
Legal
Financial Mgt
Logistics
Design

	Space Segment SE | Satellite | Payload	Ground Segment Satellite Cntl | Data Fusion	I&T Segment PM | SE | I&T

Functional-Oriented

Engineering
Test
Mfg
Suppliers
Contracting
Legal
Financial Mgt
Logistics
Design

IMP/IMS 10/54

10

There is much discussion in the project management literature about the differences between product processes and project processes. This is probably a discussion between purist, having little to do with actual project management.

In the case of IMP/IMS the project processes are defined around the product delivery processes. Without a product or service to delivery, there is little interest in in the project processes – they are simply theoretical discussions

The more important concept is the differences between product processes and functional processes.

A critical aspect of IMP/IMS is to define activities around products and their delivery rather than around functions.

Attributes of the IMP

- **Traceability**
  - Expands and complies with the SOO, Performance Requirements, CWBS and CSOW
  - Based on the customers WBS
  - Is the basis of the IMS, cost reports, and award fees

- **Implements a measurable and trackable program**
  - Accomplishes integrated product development
  - Integrates the functional activities of the program
  - Incorporates functional, lower level and S/C IMPs

- **Provides for evaluation of Program Maturity**
  - Provides insight into the overall effort
  - Level of detail is consistent with risk and complexity per §L
  - Decomposes events into a logical series of accomplishments
  - Measurable criteria demonstrate completion / quality of accomplishments

IMP/IMS 11/54

11

A good IMP has the following attributes. But most importantly a good IMP describes the logical flow of the program.

Although this again seems obvious the construction of this "program flow" requires input from all participants to assure they understand their deliverables, the sequence of those deliverables.

Attributes of an IMS

- **Integrated, networked, multi-layered schedule of efforts required to achieve each IMP accomplishment**
  - Detailed tasks and work to be completed
  - Calendar schedule shows work completion dates
  - Network schedule shows interrelationships and critical path
  - Expanded granularity, frequency, and depth of risk areas
- **Resource loading for critical risk areas**
- **Correlates IMS work with IMP events**

IMP/IMS 12/54

12

Once the IMP is in place and started to be structured, the SA/AC/Task structure can begin. This is an iterative process and continues on a rolling wave cycle at the detailed level.

There are there (3) levels of IMS in most major programs:

- Master
- Intermediate
- Detailed

The master level mirrors the IMP

The intermediate level is usually found in the proposal and contains all the end-to-end activities, but at the "macro" level.

The detailed IMS is usually a rolling wave planned at the week level. For typical NASA contracts major efforts have 20 day cycles for measuring progress, so this detailed IMS

Integrated Program Management Framework

Technical Requirements — User requirements decomposed from RFP

WBS
- Guidance usually in RFP
- Tailored to contractor's program / products
- Provides single numbering system for entire program

Statement of Work (SOW)
- Contractor generated. Based on SOW
- Guidance provided in RFP

PLACED ON CONTRACT

Integrated Master Plan (IMP)
- Event-driven plan for entire program
- Product and Process Sections

Process Metrics

IMS
- Expands IMP, Provides timing

USED TO TRACK PERFORMANCE
- Process quality measures

Technical Performance Measures

USED TO REPORT PERFORMANCE

Earned Value Management System (EVMS)
Links cost to IMS thru WBS

CPARS
Determined by performance

IMP/IMS 13/54

13

The complete end to end process is described here.

Requirements come from the customer through the Statement of Work and the Work Breakdown Structure. The Integrated Master Plan is built from these documents and of course a face to face conversation with the customer, usually in the project kick off meeting. The IMP represents the logical flow of project events, transition points or deliverables as defined in the SOW.

From the IMP the IMS is developed along with the program performance metrics for each of the IMP components. These metrics include earned value, resource utilization, milestone performance (late starts late finishes)

Objectives Of All This Formality

Objective	➜	Implementation
Event Driven Plan versus Schedule Driven Plan is based on completion of tasks not passage of time	➜	Separate the plan (IMP) from the schedule (IMS) but link elements with numbering system
Condensed, easy to read "plan" showing "events" rather than effort	➜	Indentured, outline format (not text)
Pre-defined entry and exit conditions for major program events	➜	Significant accomplishments (SA) for each key event (submitted in proposal)
Objective measure of progress/ completion for each accomplishment	➜	Pre–defined accomplishment criteria (AC) for each SA
Stable, contractual plan flexible enough to portray program status	➜	IMP is part of contract, IMS is data item
Capture essence of functional processes without mandating a particular process	➜	Split IMP into Product and Process sections

IMP/IMS 14/54

14

All this seems like a lot for effort for simply keeping track of the planned work of a project. And as a stand alone process it probably is a lot of effort. But there is a critical aspect to IMP/IMS (as well as more traditional task scheduling). That critical aspect is the "making of the schedule."

In IMP/IMS the "making of the IMP/IMS" is a process were the events, significant accomplishments, accomplishment criteria and the supporting tasks are developed from the contract source documents.

This "discovery" process is critical the success of the program in the following ways:

- The accomplishments and criteria for these accomplishments is defined up front. This "what does done look like" process reveals the true activities in place of just working.

- The sequence of events defines the maturity of the program over time. As specific events are accomplished, the program matures toward its completion. The "test" of maturity is defined by events, accomplishment, and criteria rather than the passage of time.

- Impacts from changes in the programs plan, requirements or resource can be immediately seen in how the events are impacted.

Definitions Used in IMP/IMS

- *Event*

  A major transition point in the program

- *Significant Accomplishment*

  Interim, critical or discrete activity required to complete *prior* to an event

- *Accomplishment Criteria*

  Measurable indicators of evidence that demonstrates the achievement of maturity or progress in an activity

- *Tasks*

  Work performed in support of accomplishments and their criteria

- *E/A/C*

  A combination of events, accomplishments, and criteria

- *Integrated Master Plan*

  A contractual commitment that lays out the entire program in a single plan

- *Integrated Master Schedule*

  Provides an integrated and networked time phased schedule of all program and product tasks

IMP/IMS 15/54

15

Here are the formal definitions used in IMP/IMS. These should be used as they are defined, rather than trying to adapt previous definitions to the IMP/IMS process.

IMP/IMS Action Verb Dictionary

• Available	• Obtained	• Installed	• Written
• Complete(d)	• Ordered	• Integrated	• Acquired
• Conducted	• Met	• Loaded	• Analyzed
• Defined	• Prepared	• Operational	• Approved
• Delivered	• Provided	• Reduced	• Awarded
• Documented	• Published	• Released	• Corrected
• Delivered	• Received	• Tested	• Drafted
• Demonstrated	• Refined	• Updated	• Established
• Established	• Reviewed	• Validated	• Generated
• Finalized	• Submitted	• Verified	• Identified
• Implemented	• Trained	• In-Place	• Initiated

IMP/IMS 16/54

16

IMP/IMS is an "action" oriented process. Verbs are used to describe activities. Past and present tense is used in specific ways.

Past tense verbs for PE/SA/AC and present tense for tasks.

It is important to adhere to this convention and not lapse into the task oriented description of work.

The verbs above are many times placed in a dictionary of the program. If IMP/IMS elements have verbs NOT found on the list then they either need to be evaluated and added or the IMP/IMS element needs to be edited.

The psychological aspects of these verbs is subtitle at first. By stating a past tense action the read (and IMP/IMS user) is motivated to see what work "was" accomplished to complete the event.

IMP/IMS Components

- **This is different than a task oriented schedule where effort is connected to milestones**

```
                                              ┌─────────────────────────┐
                                              │ Event (System or Product)│
                                              └─────────────────────────┘
                                                          ▲
                          ┌─────────────────────────┐     │
                          │ Significant Accomplishment│    │
                          └─────────────────────────┘     │
                          │ Significant Accomplishment│────┘
                          └─────────────────────────┘
                                        ▲
        ┌──────────────────────────┐    │
        │ Accomplishment Criterion │    │
        └──────────────────────────┘    │
        │ Accomplishment Criterion │────┘
        └──────────────────────────┘
                    ▲
    ┌─────────────────┐  │
    │  Detailed Task  │  │
    └─────────────────┘  │
    │  Detailed Task  │──┘
    └─────────────────┘
```
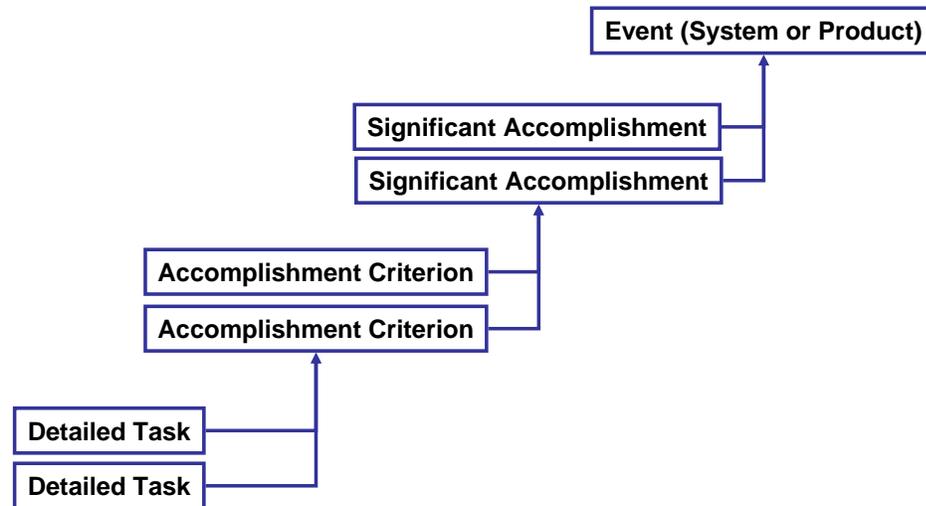
IMP/IMS 17/54

17

A quick review of the IMP/IMS components and their hierarchy is in order before moving on to more details. This time starting from the bottom. Remember this is not how the IMP/IMS is built, but it is another way to look at the relationships

- Tasks define the actual work performed on the program. These tasks deliver product or process in support of the criteria for an accomplishment. The output of the tasks should have a metric embodied in the accomplishment criteria that is a measurable outcome of the effort performed during the "period of performance."

- The accomplishment criteria describe the measurement to be assessed in performance of the work.

- The significant accomplishment defines the measurable outcome of the tasks and their criteria. This accomplishment is a tangible outcome that moves the program forward. It is an assessment of the maturity of the program as well as an incremental progress toward the goal of the program. In the spacecraft construction business the final goal is usually the launch of the vehicle into orbit or to a planet.

Preparing the IMP

- **Charter the working group**

    – Program Management Team (PMT)

    – System Engineering Integration Team (SEIT)

    – Integrated Product Team (IPT)

    – Certified Principle Engineer (CPE)

- **Functional managers if they are organized along functional disciplines**

IMP/IMS 18/54

18

The preparation of the IMP is a semi-formal process. For proposal work the proposal team bursts the RFP and lays out the WBS and SOW. For a post-award program the SOW, WBS and contract are the basis of the IMP.

The key element of IMP development is to have the appropriate number of events while capturing program maturity and progress rather than just the passage of time.

There will be standard government milestones (PDR, CDR, etc.) The remaining events must reflect maturity measurements, transition points, handoff points, join up points, and other times in the program where assessment and evaluation can take place.

These points must be tied to the risk mitigation processes as well.

At these points the entire team (contractor and customer) must have to opportunity to evaluate the program for compliance as well as risk assessment.

"Free and frank" questions and answers need to performed at these points.

Preparing the IMP

- **Inputs for the IMP**

    – Statement of Work (SOW)

    – Work Breakdown Structure (WBS)

    – WBS Dictionary

    – Contract Line Item Numbers (CLIN)

    – Contract Data Requirements List (CDRL)

    – Data Item Descriptors (DID)

    – Program Requirements List (PRL)

    – Organizational Breakdown Structure (OBS)

IMP/IMS 19/54

19

The obvious inputs for the IMP come from the obvious places. In fact there aren't really any non-obvious places to find information for the IMP.

But an exhaustive search is necessary since the IMP will not only be a contract document, it's quality will be the basis of success for the program.

Preparing the IMP

- **Each IPT plans, tracks, and executes its own efforts in a fully integrated manner through the IMP**

- **The IMP seamlessly integrates elements of the management process using an event-based code and numbering scheme**

- **Using the IMP/IMS verb dictionary construct an indented structure of E/A/C/Tasks**

  – Use past tense verb for E/A/C at end of sentence

  – Use present tense verb for tasks at beginning of sentence

There is a powerful effect of stating the completion criteria instead of the level of effort needed to complete the task.
This defines upfront - What does done mean?

IMP/IMS 20[/54]

20

The preparation of the IMP is a team effort. It is also iterative and incremental.

It is iterative because the program requirements are usually complex and convoluted. Many passes through the requirements are needed to build a clear and concise "event map." If the requirements are held in electronic form (DOORS) then mapping requirements to events can be done electronically as well. In the proposal there is usually a map between proposal subsections and the SOW as well.

It is incremental because of the hierarchical nature of the IMP. Developing too much detail too soon commits the IMP/IMS too early as well. Incrementing the levels of detail provide numerous opportunities to re-direct the program architecture early in the IMP/IMS development process.

A properly developed IMP/IMS should contain labor and cost spreads against the tasks. If the structure of these tasks is committed too soon, re-doing the labor spreads will be tedious at best and avoidable at worse.

Three Sections of the IMP

- **§1 – *Overview* – summarized key elements of the product process narratives and methodology for developing the IMP**

- **§2 – *Product IMP Matrix* – PE, SA and AC structure for the program**

- **§3 – *IMP Process Narratives* – description of how to manage and perform the contract effort defined in the IMP Matrix**

IMP/IMS 21/54

21

In a formal process there are three sections of the IMP. This is a proposal based approach, so ongoing programs will likely not find value here.

This brings up the issue though of doing a good IMP/IMS during the proposal, so when award comes it will be an easy transition from the Basis of Estimate costing to the actual costing model.

As well the decomposition work should follow a product structure rather than the traditional functional structure. In the product decomposition Events and Significant Accomplishments can be easily identified. In the functional structure Events and Significant Accomplishments are more difficult to identify, since the passage of time is the primary metric of functional organizations.

Pseudo-product structures are a problem, since they look like product structures but are actually functional structures. Care must be taken to clearly identify Events and Accomplishments not matter the structure. IMP/IMS depends on this clarity and without it the business benefits of IMP/IMS is lost without the users actually knowing it.

Define / Derive Deliverables

- **CLINs list customer deliverables**

- **Items needed to support the CLINs**

- **Assign every product to an IPT, then to a CPE with full authority to deliver**

- **Summarize each product life cycle in the IMP**

IMP/IMS 22/54

22

More sources of Events can be found in the CLINs and IPT Statements of Work

Criteria for Defining Events

- **Customer provided events**

- **Key decisions**

- **Risk mitigation events**

- **Mandatory corporate events**

- **Capability demonstrations**

- **Verification efforts**

IMP/IMS 23/54

23

The customer provides other sources as well

Typical IMP Events

- **ATP – Authorization to Proceed**

- **IBR – Initial Baseline Review**

- **IBR – Integrated Baseline Review**

- **SRR – Systems Requirement Review**

- **SDR – System Design Review**

- **PDR – Preliminary Design Review**

- **CDR – Critical Design Review**

- **TRR – Test Readiness Review**

- **PCA – Physical Configuration Audit**

- **FCA – Functional Configuration Audit**

- **IOC – Initial Operating Capability**

- **FOC – Final Operating Capability**

IMP/IMS 24/54

24

External events are common in government procurement processes as well

IMP/IMS Numbering Scheme

- **Coding system links key Events to responsible IPTs, SAs, ACs, and Tasks**

A	01	B	01	a	1001

Event

IPT

Significant Accomplishment

Accomplishment Criteria

Task

CWBS

IMP/IMS 25/54

25

One attribute of IMP/IMS is a common numbering system. This approach is emphasized in many guides and training sessions. Its importance depends on the program structure. In a complex IPT structure common numbering is the glue between the IPTs.

In many other programs this common numbering provides little value since there are other common numbering schemes in place. Charge Account numbers, CWBS, Work Packages are used in homogenous program teams to serve as IMP/IMS numbers.

Defining Accomplishments

- **SAs are event related not just time coincidental**

  - The passage of time has little to do with real progress

  - These events *should* not be anchored at a specific date, unless imposed by the customer

  - The date of the event *should* be driven by the supporting work that must be accomplished

- **Accomplishment characteristics**

  - A discrete step in the process of planned development

  - A desired result at a specific event

  - Interrelationships, interdependencies, or handoffs points

IMP/IMS 26/54

26

The use of Significant Accomplishments is the first departure from task-based planning. SA's ask "what have you done that moves this project along?"

SA's of course are the meat and potatoes of the Events. They are the "actionable outcomes" that are the basis of the Event.

The emphasis is on "action," doing something that is evidence of accomplishment, not just the passage of time.

The SA's must be discrete increments, wholly intact deliverables. In the philosophy of Earned Value, credit for accomplishments is 0% or 100%. No partial credit. This may not always be the case, but it should only be a special case where partial credit is taken for performance of the accomplishment.

Sample Accomplishments

- **Accomplishments are past tense.**

- **Activities that have been performed with measurable outcomes**
    - *EVMS processes demonstrated*
    - *System Requirements Allocations Completed*
    - *Functional Interface Requirements Established*
    - *Software Build Cycle 1 Released*

IMP/IMS 27/54

27

Using the grammatical structure of past tense verb at the end of the activity, SA's include this phrases.

The IMP/IMS style is narrative, with complete sentences (minus articles and smaller components). The reader should be able to grasp the concept by reading the activity.

If the IMP/IMS task names (in Microsoft Project) were read top to bottom it would be a properly formed description of the work performed during the program.

The approach avoids task names like: "Build software," which are vague, do not describe the outcome, and contain not measurable activities. Such a statement contains a verb "build" but nothing that can be measured.

The passage of time in "build software" would seem to deliver the software at the end of the task. But as well all this does not happen. The reason for this is more complex than IMP/IMS can address. But IMP/IMS is the first step in removing the vagueness from the schedule by stating measurable outcomes along the way to "building the software."

Evidence of Accomplishment

- **Accomplishment Criteria (AC) are definitive measures supporting successful completion of a significant accomplishment (SA)**

- **An AC must show objective evidence of work progress**
  - Seen, read, demonstrated, or quantified
  - Measured in an independent means, not just a statement *we're done*
  - Defining the accomplishment criteria before proceeding with the work is critical

IMP/IMS 28[/54]

28

Accomplishments are nice, they're even mandatory. But how are they judged to be compliant with the work. The Accomplishment Criteria provide the "means test" for the accomplishments.

"You say you did the work, how can I test that this work meets my needs?"

"How would I recognize that the work is done properly?"

The objective evidence approach is the way accomplishments are measured. Something deliverable – an actionable outcome – is the starting point. Something that can be held, read, demonstrated, operated, installed, used or any other variety of actionable verbs.

Integrated Master Schedule

- **IMS is a calendar oriented tool that integrates all criteria, accomplishments, and events described in the IMP.**
    - Represents relationships between tasks
    - Duration and timing
    - Scope of work

IMP/IMS 29/54

29

With the Events, Accomplishments, and Criteria in hand, the Integrated Master Schedule is the next step.

This is an easy process actually – what tasks must be performed in order to exit the Event with the accomplishments complete according to their measurement criteria?

These activities are the tasks.

The major effort here is sequencing the tasks, getting the task constraints properly assigned, resource loading these tasks.

This is not a easy effort, but the guidance for recognizing "done" has been defined in the PE/SA/AC descriptions, so now here is little vagueness of what work needs to be done.

Integrated Master Schedule

- **Depicts both planned (baselined) and forecast dates**

- **Measures impact and performance for each activity**

- **Communicates program content, workflow, and approach**

- **Identified problem areas**

- **Enables management to prioritize**

- **Is the basis for evaluating and communicating change**

IMP/IMS 30[/54]

30

Assembling all these components (PE/SA/AC/Task) in one place completes the IMS.

The IMS is an event based, accomplishment focused, criteria measured, task description of the work to be done in the program.

"Done" is now fully articulated in one place.

The IMS IS the integrated master plan, in a way no other "planning" process is.

It defines "done"

It defines the path to "done"

It defines how "done" is recognized

Using Kipling's poem, Elephant's Child

> I keep six honest–serving men
> (They taught me all I knew);
> Their names are What and Why and When
> And How and Where and Who

 The IMP/IMS provides new meaning to "integrated."

Three Levels of Schedule

- **Master – usually published with the proposal, but also the supporting basis for the IMP**

- **Intermediate – resource loaded derivative of the Master Schedule**

- **Detailed – 60 to 90 day rolling wave details at the execution level**
    - Sufficient detail to control the work
    - Deliverables at the end of the wave support the accomplishments

IMP/IMS 31/54

31

A properly formed IMP/IMS is a layered approach. In most modern project management guidelines a "rolling wave" or spiral approach is used for planning.

The "agile" community has other terms for this but most modern process are iterative and incremental. The Big Design Up Front (BDUF) approaches of the past have been shown to contain a fundamental flaw. Predicting the future without feedback from the current and past is very sporty business.

The customer wants to know the total cost to some degree of accuracy. Wants to know the risks. Wants to know the schedule. But the degree of accuracy varies as a function of time.

IMP/IMS addresses this issue with three (3) levels of schedule.

The Master schedule is usually a series of milestones and task bars for the end-to-end activities

The intermediate schedule is usually a Tier 2 or Tier 3 WBS schedule

The detailed schedule is a week to week plan of the work, resources, and deliverables.

This detailed schedule is often a 60 to 90-day rolling wave schedule designed to directly control the work.

Master Schedule Attributes

- **Key elements of contract work**

- **IMP/IMS**

- **All test articles**

- **Deliverable hardware, software and documentation**

- **Key milestones / events over the life of the contract**

IMP/IMS 32/54

32

The IMS has several important attributes. These seem obvious when stated here. Without the focus on "event" and outcomes, it is easy to fall into the trap of describing "effort" in place of "outcomes."

Intermediate Schedule

- **Reports a monthly review of program progress against schedule milestones**

- **Identified reference milestones**

- **Represents program activities to the lowest WBS level**

- **Is the product teams master schedule**

IMP/IMS 33/54

33

A monthly reporting rhythm is common these days.

"What have you done lately" is the theme of these reporting cycles.

A formal reporting document usually accompanies the meeting. For NASA it is the 533M. For DoD it is the monthly CPR.

For a program of nearly any size some type of formal report and review of progress is needed – just to keep every focused on progress.

Detailed Schedule

- **Lowest tier baseline schedule**

- **Cost Account focused with authorized work divided into a logical sequence of time-phased tasks**

IMP/IMS 34/54

34

The detailed schedule is where the heavy lifting gets done for the planner. This is a week to week and sometimes a day to day schedule of the work activities. Since the detailed schedule is done on a 60 to 90 rolling wave the hard work of planning is limited in time.

Well almost. One guideline for rolling waves is to start the planning of the next rolling wave long before the completion of the current rolling wave. But the "planning packages" developed in the intermediate schedule lay the ground work for the detailed rolling wave plan. It's still hard work but it doesn't all get done in a single sitting.

By layering the planning process, iterative and incremental behaviors are enforced.

IMS detail tasks are statused on a weekly basis. Status includes accomplishments, forecasts (late or early), and schedule changes. Using the Schedule Activity Task Identifier he IMP/IMS number), weekly detail activity status in the IMS is used to determine the monthly control account work package status. The Critical Path network in the detailed schedule provides the schedule impact to the program in comparison to the baseline schedule.

IMP / IMS Assembled from the RFP

Requirement	WBS Element	SOW Task

System Specification
1000 Spacecraft
1100 Avionics
Ground Link

1000 Spacecraft
1100 Avionics
1110 Ground Link
.
11n0 *Avionics*

§3.1 Structure (WBS1000)
Design, develop, produce and verify a complete spacecraft containing avionics, propulsion and other installed equipment.

Integrated Master Plan (IMP)

Management Plan	Events	Accomplishment Criteria
1. Preliminary Design Review	PDR	1. a. Duty cycle defined b. Preliminary analysis complete

Integrated Master Schedule (IMS)

	2004	2005	2006
Program Events		PDR	CDR
1. Preliminary Design Complete	◆————	————◆	
2. Duty Cycle Defined		◆————	————◆

IMP/IMS 35/54

35

This is a very simple (notational) picture of the IMP/IMS assembled from the requirements. This is one of those pictures that is both obvious and subtle at the same time.

It is obvious because there is no information not already known by the planner. It is subtle because the development of the hierarchy of Events, Significant Accomplishments, and Accomplishment Criteria is not actually described in this picture.

This by the way is the problem with most IMP/IMS training. It shows all the parts but does not tell the reader how to assemble the parts into a viable IMP/IMS.

But this is a starting point. We'll get to a "real" IMP/IMS later.

A Very Simple IMP/IMS (not very useful)

Activity #	Program Event (PE) Significant Accomplishment (SA) Accomplishment Criteria (AC)	WBS
E	*Event E – GN&C Flight Units Complete*	
E01	*Release 1 Flight Production Complete*	—
E01a	Release 1 Subassemblies Complete	3.1.2.2
E01b	Release 1 Assembly/Integration/Test	3.1.2.2
E02	*Release 1a Flight Production Complete*	—
E02a	Release 1a Subassembly complete	3.1.2.4
E02b	Release 1a Asmbl/Test/Launch/Ops	3.1.2.4

IMP/IMS 36[/54]

36

Again this is a "carton" of on IMP/IMS. This gentle introduction is meant to familiarize you with format before content. The content is harder to come up with, so format is a natural starting place.

A Fully Integrated Framework
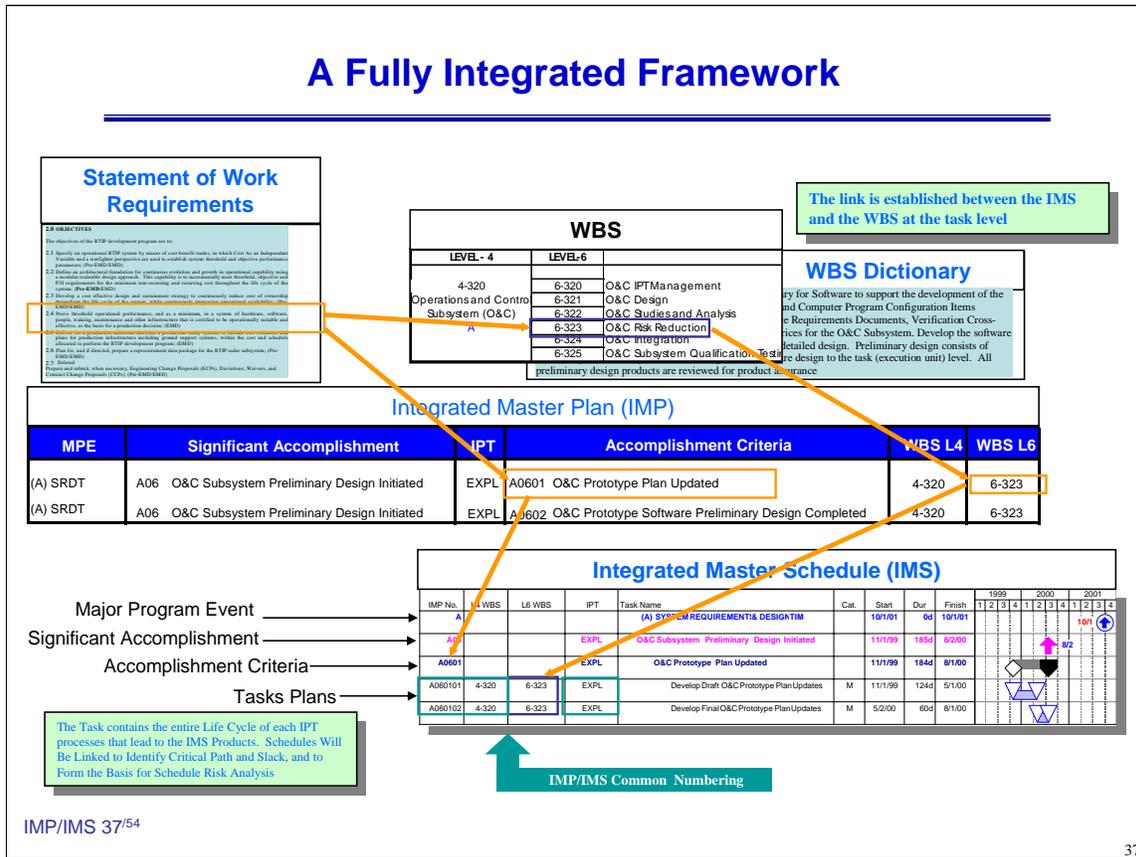
Now for the obligatory "big picture."

Here are all the components of an integrated framework using IMP/IMS.

You'll see all the components presented in previous slides and there relationships.

Without some key of automation, this is going to be a mess for any sizable program.

But rushing to automation should also be avoided, since the value of IMP/IMS is in the "making," rather than in the completion – not that a completed IMP/IMS is not our ultimate goal.

This slide is borrowed from another slide show, as is likely that slide show. So if you've worked at other aerospace firms this may be recognizable.

Note the traceability between requirements, the WBS and its dictionary, the IMP and the IMS.

Naming Events, Accomplishments and Criteria

- **Events, Significant Accomplishments, and Accomplishment Criteria**
  - Declarative sentence ending with a past tense "verb"
  - Version 1 Subassemblies Completed
- **Tasks**
  - Declarative sentence starting with a present tense verb
  - Receive Raw Materials
- **Color code each E/A/C/T to indicate differences**
- **Use BOLD Underlined Italic fonts to show differences**

IMP/IMS 38/54

38

Let's talk about "style." There are several styles for IMP/IMS. Our style is driven by the capabilities of Microsoft Project. Project is a hierarchy oriented tool. This means that work s defined in an indented structure. Summary tasks are created by indenting subordinate tasks. The levels on indenture are nearly unlimited – I've never really tested the limit though.

For IMP/IMS the obvious levels of indenture are four – matching the four components of IMP/IMS.

In order to keep things straight color can be used as well. This puts a burden on planning to have a color printed, preferably a double sided color printer.

Using color, underling, italics and bold, the PE/SA/AC/Task components can easily be distinguished.

The "trick" (and there is one" is to use flags for each Microsoft Project task to identify the type of component. Then using filters isolate each component and format it according to its type.

The convention for formatting is simple

Event (red Bold)

Significant Accomplishment (Blue Bold)

Accomplishment Criteria (Black, Normal, Underlined, Italic)

Task (Black Normal)

Building an Integrated Master Plan

- *"How hard can this be, we've built plans before?"*

- **Turns out there are some subtleties to a good IMP**

  – Some events are obvious – PDR, CDR, TRR

  – Most are more difficult – IF approached from the functional work allocation point of view

    • Product focused deliverables

    • "True" assessment points beyond the obvious reviews

    • Integration, verification, assembly, test completion, operational assessment and other visible, tangible, measurement points are possible candidates

  – These seem obvious as well, and some likely are, but others are still hiding in the details of the WBS

IMP/IMS 39/54

39

So far so good.

But now we need to start putting together a real IMP/IMS.

First the list of events may already be defined in the contract. PDR, CDR other "Rs" are likely defined in the RFP and have been carried over to the contract and now in the award kick off meeting the customer wants to see them again in the IMP.

But other events need to be defined as well. If the planning process is "functional" orientated then these events may be difficult. That's why product focused planning is easier, since products have tangible outcomes that can be used for events, significant accomplishment, and the accomplishment criteria.

Using the guidelines stated here the components of the IMP can be captured.

Building the IMP/IMS from the WBS

- **Developing the Significant Accomplishments from the WBS to build a traceability matrix**

WBS \ PE's	SRR	SDR	PDR	CDR	TRR	ATLO
4-920- SDAI	A01, A02	B01	C01, C02	D01	E01	F01
4-200- System Test	A05	B03, B04		D02, D03	E02	F02
4-300- Radar Subsystem Software	A03	B02	C03		E03	
4-330- O&C Subsystem	A06, A07	B05	C04	D04	E04	F03, F04
4-400 Platform Integration	A08		C05		E05, E06	F05
4-500 Support Commodities	A09			D05	E07	F06, F07

→ **Major Interface/ Relationship**
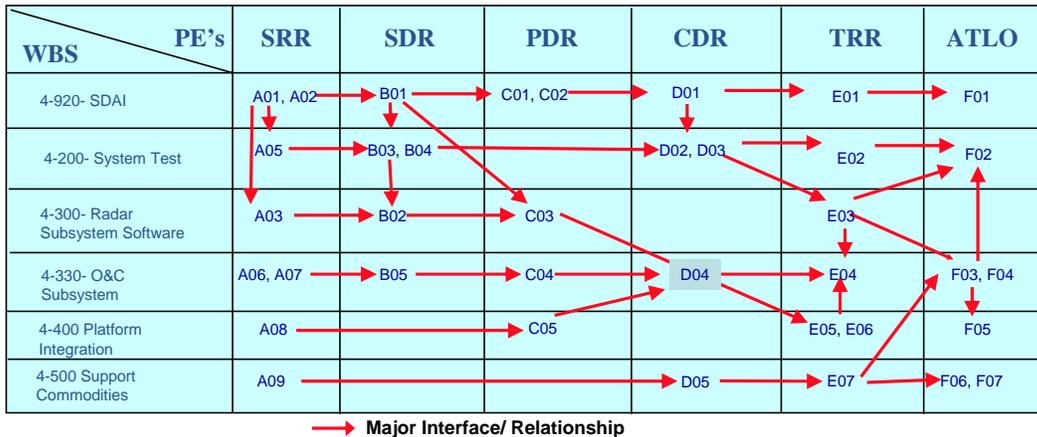
One very useful way to start is with the Work Breakdown Structure. This WBS needs to be a product focused WBS. Using the obvious set of events from the contract a map between the WBS major elements and the events can be created.

It may be this map represented all the work. But more likely there will be gaps in the lines connecting the cells in this matrix. Those gaps can be filled with new events.

Program Management Levels

Program Levels	IMP/IMS Elements	CWBS
Tier 1 **Program Manager** **Control package manager** **IPT manager** **Technical performance goals**	**Major Program Events (PE)** **Significant Accomplishments (SA)**	*Level 1 & 2* **Links to CLINs** *Level 3 & 4* **Control Packages** **Link to PBS** **Integrated EVMS**
Tier 2 **Cost Account Managers** **Product work plan** **Responsible organization elements**	**Accomplishment Criteria (AC)** **Tasks (NA)**	*Level 5* **Cost Account Package** **Cost Collection Level** **Links to WBS by OBS** **Resource summaries** **Early warning EVMS analysis**
Tier 3 **Work package manager**	**Detailed plans**	**Work package Earned value calculations**

IMP/IMS 41/54

41

Looking back at the three (3) levels of IMP/IMS and using the map between WBS and Events the level of detail at each tier can be defined.

Using Schedule Constraints

- **It is desirable to have tasks start "as soon as possible"**

    – Start determined by the relationships with predecessor tasks

    – Provides maximum flexibility to stay within constraints of the critical path

    – Changes to critical path have the least disruption to the planned schedule

- **There are times when other constraints may be needed**

    – The execution IMS should not use hard constraints

    – These types of constraints do not support credible risk assessment using CPM or Monte Carlo risk tools

IMP/IMS 42/54

42

Once the tasks, accomplishment criteria, significant accomplishments, and events have been assembled in one place (inside a Microsoft Project schedule), the tasks need to be linked.

Notice this is the "last" step not the first step. In a traditional approach the tasks and their linkage is the starting point. In IMP/IMS it is the ending point.

With the tasks defined and their initial duration specified, constraints can be placed on some of them to control their delivery.

"As Soon As Possible," "Fixed Duration," "Not Effort Driven" should be the default settings for the tasks. This will allow the planner to connect the tasks into a logic network without having to worry about resource assignments messing with the durations – at least at this point.

Soft Constraints

- **Start No Earlier Than (SNE)**
  - Tasks not control by the execution team, for which the team has been given projects dates
  - Government deliverables
  - Tasks which may have to be scheduled in conjunction with other program elements
- **Finish No Earlier Than (FNE)**
  - "Just in Time" tasks
- **Rationale needs to be provided for constraints other than "As Soon as Possible"**
  - This information should be placed in the notes field

IMP/IMS 43/54

43

The use of constraints is fraught with difficulty and risk. So let's look at the limited constraint types to go into a good IMMP/IMS.

There are only two (2) besides "As Soon As Possible."

"Start No Earlier Than (SNE)" should be used for task that cannot be controlled by the team. This usually means external tasks, government deliverables, and tasks that have to be schedules with external relationship that are themselves fixed.

"Finish No Earlier Than (FNE)" should be used for tasks that define a just in time work process. Many activities we encountered have a "aging" component. The arrival of materials, the integration sequence of materials has a time phased order. This order may not be defined in the task sequence. The materials may have been delivered in parallel. FNE is a way to control the sequence of events that are not physically dependent on each other.

Task Relationships

- **For an integrated master schedule to reflect the program status, all interdependencies must be identified**

- **Finish to Start – one task finished before another starts**

  | Write Test Procedure | → | Conduct Test |

- **Start to Start – one cannot start until another starts**

  Conduct Test → Gather Results
  SS+5d

- **Finish to Finish – completion is driven by another task**

  Conduct Wind Tunnel Test — FF+22d → Design Air Vehicle

- **Start to Finish – administrative tasks driven by a review date**

  Conduct Review → Prepare Agenda
  SF -10d
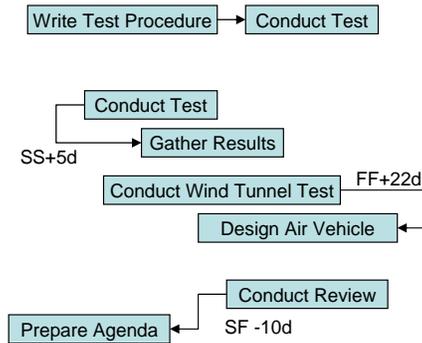
Most project scheduling programs provide a variety of ways of linking tasks. Here are the four ways Microsoft Project does it.

Finish to Start is the most common

Start to Start can be used for parallel tasks

Finish to Finish for parallel tasks as well

Start to Finish although rare is found in many review tasks that have a preparation or a pre-delivery process

Milestones

- **Deadline constraint is a powerful tool for controlling**
  - Complete prior
  - Complete after

FF-10d   FF+10d

Complete 10 days prior   Milestone Date   Complete 10 days after
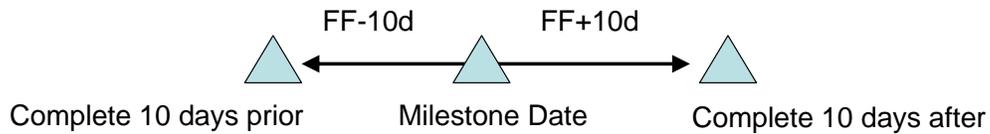
Linking milestones should be done with a deadline constraint. Milestones that precede or follow should use a Finish to Finish constraint.

Sorting the IMS

- **Using Microsoft Project™ the IMS components can be sorted**
  - Events / SA / AC / Tasks
  - Work Break Down Structure
  - CDRLs
  - IPTs

- **Using flag fields, filters and a Project Sort order are used to produce different presentation views of the IMS.**

- **The IMP/IMS number is used to sort the filtered components**

IMP/IMS 46/54

46

Let's look at how to get all these components to come out in a nice neat picture, like the ones we see in the guidebooks.

Each project task has flags (yes/no values) that are used to sort the IMP/IMS.

These flags are usually Flag1 through Flag4. Names are attached to the flags – PE, SA, AC, Task.

Filters are used to arrange the project schedule according the flags and the IMP/IMS coding number.

Flag Fields for IMP/IMS Components

IMP/IMS 47/54

The Flags Field used to identify IMP/IMS components provide filtering for display. These flags represent the hierarchy of activities in the IMS just as they will when the project is displayed.

Care needs to be taken to make sure duplicate flags are not set or that at least one flag is set. This can be done with others filters to confirm the flags are set properly.

A Filter for Events, SA's and AC's

- **Using the Flags, filters are build to construct various "views" of the IMP/IMS**

IMP/IMS 48/54

Here's a simple example of a filter the selects activities that are Events, Significant Accomplishments and Accomplishment Criteria.

Defining filters is sometimes tedious, but a complete set will serve the planner well.

The primary outcome is to be able to produce the IMP and the IMS from the same schedule in project.

Filtering a Project Schedule into an IMP/IMS

- **The filtered and sorted results show a well formed IMP/IMS**

IMP/IMS 49/54

49

Using the previous filter this is what the project looks like.

Using the IMS Post-Award

- **Communication**

  – Convey to all participants the work to be done

- **Program Tracking**

  – Directed Budget Cuts

  – "What If" Exercises

- **Reporting**

  – Contractor Performance Assessment Reports (CPAR)

  – Award Fee

  – Earned Value Management System

  – Change Control Process

IMP/IMS 50/54

50

Using the IMS for Communication

- **Flow of information between IPTs**

  – Assures all interfaces are recognized and addressed

  – Avoid team "stove pipes"

  – Provides a basis of discussion

- **Data exchange between government and contractor**

  – Electronic publishing of IMS

  – Performance tracking based on the completion of events rather than the passage of time

IMP/IMS 51/54

51

52

Program Tracking with the IMS

- **Block updates scheduled in the program management process**
  - Reporting status across an accomplishment rather than an individual task.

- **Regular program status updates**
  - Guided by the current events and the deliverables that proceed them.

IMP/IMS 52/54

52

This is the presentation format of the IMP/IMS.

Logos, footers and headers, and legends are added.

A standard way to produce a "package" is:

1. Display the events only and print this in PDF

2. Display the Events and Significant Accomplishment and print this in PDF

3. Display the CDRLs (using a filter with the CDRL flag set to TRUE and the CDRL text field completed and save this as a PDF

4. Display the complete package (PE/SA/AC/Task) and save this.

5. Open the Events only PDF and using the PDF Distiller add the PE/SA, CDRL, and complete documents into a total document.

This document can then be sent to the interested parties.

Resource Materials

- *Air Force Materiel Command: Integrated Master Plan / Integrated Master Schedule (IMP/IMS) Guide*, Version 1, November 2003.

- *The Integrated Project Management Handbook*, 8 February 2002 Dayton Aerospace, **www.daytonaero.com**

- *Scheduling Guide for Program Managers*, October 2001, Defense Systems Management College, Fort Belvoir, VA

- *Department of the Army Cost Analysis Manual*, US Army Cost and Economics Analysis Center, May 2001.

- *NASA Systems Engineering Handbook*, SP-610S, June 1995

IMP/IMS 54/54

54

The materials in this presentation are not original, but derived from the sources listed here as well as other publicly available presentations. Goggle of course is a place to start once these sources have been digested. This is an evolving topic so conferences and their proceedings are a good place as well.